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Predictive analysis of Metaverse usage intention in the Spanish University

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Abstract

In technologically advanced societies, the Metaverse has become a three-dimensional digital space that merges the real and virtual worlds, creating new scenarios and possibilities for social interaction. Considering the early stage of its development, the goal of this research is to provide knowledge on the will and intention of university students to use the "Metaverse" for educational purposes, identifying the relevant influential factors on the matter. This would contribute to the assessment and possible action of higher education institutions regarding the integration of this technology in the design of teaching–learning activities. For this purpose, an *ex post facto* research methodology with a prospective design has been used, relying on a survey conducted with a specially designed questionnaire based on the extended version of the Unified Theory of Acceptance and Use of Technology, covering a sample of 480 university students. Descriptive analysis and structural equation modeling were performed using SPSS and SmartPLS. The influence intention to use the Metaverse were reduced to three dimensions: performance behavior, social influence, and perceived value. The obtained results consolidate, on a theoretical level, the robustness of the Technology Acceptance Model (UTAUT-2). From a practical point of view, they serve to inform tool developers about the aspects to be prioritized and strengthened for implementation of such technological instruments in a teaching–learning context. Therefore, the study provides relevant information about the integration of the Metaverse in educational institutions, especially at the university level, focusing attention on universities as necessary active protagonists of such process.

Keywords Metaverses · Online education · Virtual education · University education · Information and Communication Technologies

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Introduction

Advances in Information and Communication Technologies (ICT) have led to changes in the way numerous services are enjoyed, many of which an accessed in digital spaces but whose actions affect the real physical world (Huang et al., 2022). Currently, from a technological perspective, the Metaverse is understood as a three-dimensional digital space that blends real and virtual worlds, where participants can interact by performing multiple activities through immersive, multisensory, multitechnological, and multi-user environments (Lee, 2021).

In this context, there are several platforms that can be considered as precursors of the Metaverse (Second Life or Minecraft) or that provide access to their own Metaverses, such as Roblox or Zepeto (Park et al., 2022), although it is perhaps Meta Platforms Inc. the company that has invested the most (Minzheong, 2022) in this area with the goal of creating the most modern and functional Metaverse.

Given its intrinsic characteristics, it is not surprising that the possibilities of the Metaverse are beginning to be explored from an educational point of view (Rospigliosi, 2022), trying to determine its potential for improving training processes as well as teaching–learning methodologies and strategies. Moreover, the Metaverse could be the protagonist of the next revolution in the field of online training or e-learning (George-Reyes et al., 2023).

However, since we are currently in a moment when the Metaverse is in a process of incipient development (Lee et al., 2022), it may be interesting as a first step to analyze the predisposition of students to use it, and to determine to what extent they are willing to incorporate these technologies as an option in the different activities of their lives, mainly in educational and academic activities.

Some studies have already moved towards this direction (Alfaisal et al., 2024; Maghaydah et al., 2024; Song et al., 2023), although the comparison of outcome yields inconclusive results and makes it therefore difficult to establish a frame of reference or generalizable conclusions. This is because, while the interest in the Metaverse as a new technology with educational potential is emerging globally, research in this area is still incipient. In fact, there are hardly any papers on this topic of study before 2020, and those that do exist are from countries/regions with a high level of technological development, such as China, South Korea, Taiwan, and USA (Roy et al., 2023). Moreover, most studies in this regard deal with the willingness of students to adopt such technology on the basis that it is not yet a massively available technology or to present the results of some pilot studies that have been carried out with the intention of testing their results. However, other studies, such as Song et al. (2023), are beginning to explore applications such as the *"Learningverse"* to support teaching, social and cognitive presences.

In Spain, research on the use of the Metaverse is at a very early stage. Unsurprisingly, it is one of the least researched of the countries that have had a look at it (Roy et al., 2023), reducing it, to the same extent as at the international level, to some pilot experiences of real use in the field of technology careers (Rojas et al., 2023; Solanes et al., 2023) or to some generic analysis of knowledge and attitudes towards technologies (Castaño-Calle et al., 2022).

In this context, therefore, the role of this technology does not seem to have been analyzed from the perspective of a potential tool for widespread use, a gap that this research aims to fill, especially in the Spanish context, although without ignoring its contribution to the search for consistent results that contribute to consolidating knowledge at the international level. In short, the study arises from the need to advance in the knowledge of an issue that globally affects the university educational environment as a whole (Chua & Yu, 2023; Roy et al., 2023): students, as eventual users of a technology that may have an important potential for their performance; teachers, as facilitators of knowledge, who might be interested or required to integrate its use in the institutional design and planning of teaching–learning processes; and the institutions themselves, since they will have to adapt to the introduction of a new technology in the organizational context.

Overall, this study attempts to deepen this line of research by testing the theoretical model that predicts the intention to use new technologies in specific contexts.

Likewise, it aims to advance from an applied perspective, identifying the factors that favor the use of the Metaverse by university students, providing data for the search of more consistent and generalizable results, while trying to determine the influence of the contextual conditions of the national environment. This would enable not only to know the motivations that lead students to use these tools, but also to encourage educational institutions to take advantage of their educational potential on a massive scale, something that has not been considered so far.

Here, the extended version of the Unified Theory of Acceptance and Use of Technology (UTAUT-2) (Venkatesh et al., 2012) comes into play, which identifies critical factors and contingencies related to predicting behavioral intention to use a technology and its use. In fact, UTAUT-2 has been a theory with special relevance in predicting the intention to use a technology in a given context due to its advantages related to its prudence, robustness, and simplicity (Alkhwaldi, 2024). This means that it has been evaluated and endorsed in multiple settings, resulting in a more favorable option compared to other options (Venkatesh et al., 2016).

With contextualization in that theoretical and implementation framework, this research aims to answer the following questions: (a) what are the factors that condition the intention to use the Metaverse for educational purposes at the university? (b) how would they affect the educational process according to the students' perspective? (c) how would they affect the students' intention to use the Metaverse for educational purposes according to the students' perspective?

Finding the answers to these questions would not only make it possible to predict the extent to which this technology is likely to be integrated into the academic environment, but also to delve into the most relevant aspects of its widespread use, which is essential for adjusting its adaptation to the reference context, bearing in mind that this technology is still in the process of being developed.

In this sense, the main purpose of the study is to identify the factors that may influence the intention of university students to use the "Metaverse" for educational purposes. This would help higher education institutions to integrate this technology, considering it when designing and planning teaching–learning processes.

This paper is structured as follows. section "Theoretical background" illustrates the theoretical background to identify the main variables and to define the hypothesis

included it in the research model. Afterwards, the model is validated though an empirical research. Section "Material and methods" explains the materials and methods implemented to validate the research model. Section "Results" describes the main results of this research. Finally, section "Discussion and conclusions" is devoted to discussion and conclusions, theoretical and practical implications, limitations and future work.

Theoretical background

The Unified Theory of Acceptance and Use of Technology (UTAUT) was intended as a unified theoretical model to provide a useful tool for assessing the likelihood of success of the introduction of new information and communication technologies in a given context (Venkatesh et al., 2003). In this way, it helped to understand the factors that influence the acceptance of such technology by users, in order to proactively design interventions that facilitate the acceptance and use of new systems. The four initial factors identified by this model were: performance expectancy, effort expectancy, social influence, and facilitating conditions.

Subsequently, the rise of technologies required the extension of the UTAUT model beyond the organizational context by generalizing it to the consumer context, which emphasized the importance of hedonic value concerning technology users. This led to the inclusion of three new constructs: hedonic motivation, price value, and habit (Tamilmani et al., 2021). This new extended version was called UTAUT-2. It had the advantage of significantly increasing the predictive role of consumer intention to use. Therefore, it consisted of seven factors (Tamilmani et al., 2021; Venkatesh et al., 2012): performance expectancy, which is understood as the perception of the degree to which a technology would help to achieve performance improvements; effort expectancy, which refers to the perception of the degree of ease associated with using the system; social influence, which refers to the degree to which an individual believes that others will use the new technology and that they think it would be important for them to use it; facilitating conditions, which refer to the degree to which one believes that there is an organizational and technical infrastructure that supports the use of the new system; hedonic motivation, which is defined as the degree of enjoyment or pleasure derived from the use of a technology; price value, which is understood as the result of the relationship between the cost of adopting a technology and the positive results it provides (cost/benefit ratio); and habit, which is understood as the degree to which the use of such technology is automated due to learning.

Hypothesis

As mentioned above, the development of the Metaverse is still at an early stage, which is why, despite its importance, very little research has been done on it so far (Lee & Kim, 2022; Teng et al., 2022), as it is specially remarkable for the case of Spain. However, some of the few existing studies have tried to predict the

intention to use the Metaverse, with the aim of analyzing the factors that influence its adoption, in some cases using the extended version of the UTAUT. In this regard, the outstanding study by Teng et al. (2022) assessed the intention to use the educational Metaverse "Eduverse" among Chinese university students, to associate the several factors with student satisfaction. Also, Lee and Kim (2022) used an UTAUT-based model to evaluate the acceptance of the Metaverse platform "Ifland" by university students. With a similar perspective, Akour et al. (2022) studied the factors influencing the acceptance of the Metaverse by university students in the Persian Gulf region.

In this sense, this paper aims to analyze the factors that can influence the university students' acceptance and intention to use regarding the Metaverse "Meta" in the educational context. For this purpose, the study is based on 7 research hypotheses that are derived from the dimensions of analysis that configure the extended version of the Unified Theory of Acceptance and Use of Technology. These dimensions are: (1) performance expectations; (2) effort expectations; (3) social influence; (4) hedonic motivation; (5) price value; (6) facilitating conditions, and (7) habit.

Nevertheless, it seems appropriate to examine the hypotheses of usage intentions by analyzing the incorporation of the latest technologies that have recently been effectively implemented in the educational field, taking into account the embryonic nature of the Metaverse, which makes it an unstable technology that has not yet been integrated into university teaching.

In this regard, Terblanche et al. (2023) examined the factors that influence the acceptance of e-learning technology at the post-COVID-19 stage, using a sample of accounting students from residential universities in South Africa. Among the results obtained, they observed that performance expectations, social influence, facilitating conditions, and habitus influence the intention to use online learning applications. Similarly, Zacharis and Nikolopoulou (2022) found that outcome expectations, social influence, hedonic motivation, and habits are relevant to predict intention to use e-learning platforms in a university context. Ahead, the importance of social influence as a predictor of intention to use e-learning methods was demonstrated in structural equation modelling analyses by Goto and Munyai (2022).

In terms of intention to use the Metaverse itself, studies such as that of Wiangkham and Vongvit (2023) have already shown that performance expectations and social influence are factors to consider in predicting intention to use the Metaverse for learning, although they found that cybersecurity was an additional relevant variable in this case. Similar results were found in the studies of Di Natale et al. (2024), who showed that the most powerful variables for predicting the intention to use immersive virtual reality technology (including the Metaverse) were performance expectations, effort expectations, social influence, and facilitating conditions.

Thus, the first research hypotheses are proposed, taking into account the consistency of the results regarding performance expectations and social influence, as well as the absence of effort expectations:

H1 Students' developed performance expectations will influence their intention to use the Metaverse as a pedagogical tool.

H2 Students' effort expectations will not affect the intention to use the Metaverse as a pedagogical tool.

H3 Social influence and intention to use the Metaverse as a pedagogical tool will have a direct effect in the intention to use the Metaverse as a pedagogic tool.

Meanwhile, in terms of hedonic motivation and price value, it is worth quoting the work of Twum et al. (2022), whose objective was to examine the factors influencing the intention to use e-learning during the COVID-19 pandemic. These authors found that perceived financial cost, performance expectancy, hedonic motivation, and social influence had a significant effect on the intention to use the e-learning methods. Also studying the intention to learn through online tools, Xu et al. (2022) obtained similar results, finding a direct relationship of effort expectancy, social influence, hedonic motivation, price value and habit with intention to use, obtaining the most significant statistical differences in the last two cases. In Metaverse studies, Sowmya et al. (2023) showed that hedonic motivation was a relevant variable influencing users' willingness to adopt the Metaverse, presenting evidence of positive moderation with personality traits through which they influenced intention to use. Similarly, Maghaydah et al. (2024) showed that the intention to use the Metaverse in education was determined, among other variables, by the perceived value and benefits that students could derive from it. Therefore, it seems appropriate to state the following hypotheses:

H4 Hedonic motivation will condition the intention to use the Metaverse as a pedagogic tool.

H5 Price value will determine the intention to use the Metaverse as a pedagogical tool.

Finally, previous studies have already mentioned how habitus is related to the intention to use online learning applications, something that also occurs when analyzing the use of mobile devices in the classroom (Sitar-Taut & Mican, 2021).

In terms of facilitating conditions, Kosiba et al. (2022) used a model based on the UTAUT-2 to examine students' use of and satisfaction with e-learning in a developing country and they concluded that neither effortful expectations nor facilitating conditions influenced intention to use. The same was true in Musa et al.'s (2022) research on the implementation of an online learning management system (LMS) in a Malaysian university. Regarding Metaverse, Kalinkara and Ozdemir (2024) found evidence that habitus was an important variable in explaining not only the intention to use the Metaverse, but also the use of the technology itself. Facilitating conditions also explained intention to use in this case, a result that, however, is not consistent with other research contributions such as that of Wiangkham and Vongvit (2023), who did not find this influence. In this sense, it would be appropriate to formulate the last two hypotheses:

H6 The existence of facilitating conditions in the students (technological skills, availability of computer devices, previous knowledge...) will not influence the intention to use the Metaverse as a pedagogical tool.

H7 The habit of access and use of Internet services and ICT tools will determine the intention to use the Metaverse as a pedagogical tool.

Research model

After an extensive literature review, Fig. 1 shows the research model proposed in this study to understand the relationships between the 7 dimensions described previously and the intention to use the Metaverse as an educational tool.

Material and methods

This study is an *ex-post-facto* design, specifically a single prospective group design (Fontes et al., 2005), in which the relationships between the variables that attempt to predict the criterion variable under study are studied. For other reasons, a non-probabilistic program of the random type (Rodríguez-Sabiote et al., 2022) was used for the selection of the program.

In this case, we used the SPSS v.27 statistical package to perform the descriptive analyses. Afterward, we use SmartPLS 4, a statistical tool used to examine the data using partial least squares equation modeling (PLS-SEM) (Ringle et al., 2024). It is active and is adding features and enhancing the ease-of-use of reporting and

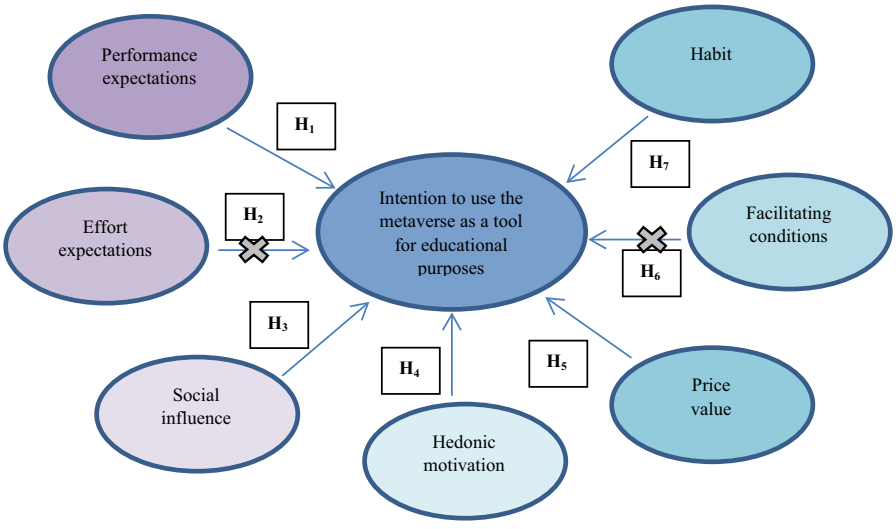

Fig. 1 Research model

analysis. PLS-SEM is a nonparametric technique, the dataset may not follow a normal distribution, which is advisable when using small samples, which makes it an appropriate technique for this type of research.

Sample and data collection

The research hypotheses proposed in the previous section were evaluated relying upon primary information obtained through surveys. The questionnaire was passed during the second semester of the 2021–2022 academic year and the two semesters of the 2022–2023 academic year. Firstly, there was a previous contact with a group of teachers to whom the objective of the research and the evaluation instrument for review were presented. Once participation was accepted, the researchers went to the classroom and provided a link for students to access the questionnaire, which was available through the Google Forms application. In addition, the research team made themselves available to the students to answer any questions that might arise while completing the questionnaire.

The questionnaire contained an introductory paragraph describing the general characteristics of the research, guaranteeing compliance with the ethical principles inherent to this type of study (explicitly stating the conditions of anonymity and data protection), and thanking for cooperation. This was followed by a link to a short video presentation of the Metaverse "Meta" and its educational possibilities (META, 2021), followed by the completion of the instrument.

The sample consists of 480 subjects from a university in Spain, mostly female (71.5%), given the typical feminization of the degrees concerned. The respondents have an average age of 19.51 years (SD = 3.183), with a mode of 18, since they are mainly first year students (83.8%). The sociodemographic profile of the sample studied is detailed in Table 1.

It should also be noted that testing for nonresponse bias is an important criterion in the analysis of survey data. This is because of the potential for inconsistencies between the responses of early and late participants. It can be concluded that there is no problem of bias in this study, using the method proposed by Armstrong and Overton (1977).

Instrument development

Data collection was conducted through the ad hoc design of a questionnaire based on the extended version of the Unified Theory of Acceptance and Use of Technology (UTAUT-2) (Venkatesh et al., 2012).

The instrument consists of 56 items divided into eight dimensions. The first dimension consists of 13 items corresponding to personal and socio-demographic data. The first dimension consists of 13 items corresponding to personal and socio-demographic data, including selected and open-ended questions on gender, age, education, degree, etc., as well as prior knowledge of the Metaverse and the intention to use it.

Table 1 Sample description

Variables	N	(%)
Academic course		
2021–2022	242	50.4%
2022–2023	238	49.6%
Gender		
Man	135	28.1%
Woman	343	71.5%
No binary	2	0.4%
Degree		
Early childhood education	212	44.2%
Primary school	194	40.4%
Double degree in Business Administration and Law	51	10.6%
Educational sciences	9	1.9%
Others	14	3%
Course		
1º	402	83.8%
2º	16	3.3%
3º	5	1.0%
4º	46	9.6%
5º	11	2.3%
Performing paid work		
Yes	109	22.7%
No	371	77.3%
Have you heard until now about the Metaverse?		
Yes	259	54%
No	221	46%

The remaining seven dimensions are listed below. They are answered on a 4-point Likert scale (1—strongly disagree, 2—disagree, 3—agree, and 4—strongly agree). These dimensions are in turn composed of a variable number of items: performance expectations (8 items), effort expectations (6 items), social influence (5 items), hedonic motivation (6 items), price value (6 items), facilitating conditions (6 items), facilitating conditions (6 items), and habit (6 items). Table 2 shows how items are assigned to each dimension.

Results

Statistical analysis of the data was performed using the SPSS v.27 statistical package, which was used to perform the descriptive analyses, and SmartPLS 4, a statistical tool used to examine the data using partial least squares equation modelling (PLS-SEM) (Ringle et al., 2024).

Table 2 Measurement scale

Dimension	Item	Description
Performance expectations	PE1	The Metaverse will allow me to access a wider range of educational opportunities
	PE2	The Metaverse will help me interact more with my colleagues
	PE3	The Metaverse will help me interact more effectively with my peers
	PE4	The Metaverse will help me interact more with my teachers
	PE5	The Metaverse will help me interact more effectively with my teachers
	PE6	The Metaverse will help me get my academic work done more quickly
	PE7	The Metaverse will help me do my academic work more effectively
	PE8	The Metaverse will allow me to improve my academic performance
Effort expectations	EE1	I think it will be easy for me to learn how to use the Metaverse
	EE2	I think I'll learn to use the Metaverse quickly
	EE3	I think the administration of the Metaverse will be intuitive and understandable
	EE4	I think I will be able to learn to use the Metaverse without special training
	EE5	I am aware that I will need to learn how to use the Metaverse
	EE6	I believe that using the Metaverse will make accessing educational content easier
Social influence	SI1	I think the use of the Metaverse will be widespread in society
	SI2	I believe that the people I interact with will use the Metaverse
	SI3	I believe that knowing how to use the Metaverse will be an essential requirement of the future education system
	SI4	I think my teachers will include the use of the Metaverse as part of their methodological strategy
	SI5	I think students will use the Metaverse for educational purposes

Table 2 (continued)

Dimension	Item	Description
Hedonic motivation	HM1	I have a positive attitude or expectation about using the Metaverse
	HM2	I think I will enjoy using the Metaverse
	HM3	I think using the Metaverse will be fun
	HM4	I think using the Metaverse for educational purposes will be motivating
	HM5	I think using the Metaverse for educational purposes will increase the playful component of learning
	HM6	I think using the Metaverse will make academic education more fun
Price value	PV1	I believe that accessing the Metaverse will have a reasonable cost
	PV2	I think I will be able to afford the computer equipment necessary to access the Metaverse
	PV3	I believe I can afford a connection of sufficient quality to access the Metaverse
	PV4	I believe the university will provide the infrastructure and equipment to access the Metaverse
	PV5	I believe that access to the Metaverse will allow me to recoup the costs of accessing the Metaverse
	PV6	I believe that using the Metaverse can reduce the cost of education
Facilitating conditions	FC1	I believe I already have most of the equipment necessary to access the Metaverse (Internet connection, computer equipment, webcam, helmet, virtual reality goggles, etc.)
	FC2	I believe that my current technological skills are sufficient to use the Metaverse
	FC3	I have created avatars and navigated virtual worlds in various Internet applications
	FC4	I have accessed Metaverse-type services such as Second Life, VR Chat, Decentraland, etc
	FC5	I have someone to turn to when I have difficulties using technology and the Internet
	FC6	I believe that my university will have a positive attitude towards the implementation of the Metaverse

Table 2 (continued)

Dimension	Item	Description
Habit	HA1	I frequently use Internet services
	HA2	I frequently use social media
	HA3	I use video conferencing and other communication tools on the Internet
	HA4	I am familiar with the use of educational tools via the Internet
	HA5	Take courses or complete training in an e-learning modality
	HA6	I collaborate over the Internet for educational purposes

For this purpose, this research uses the two-step procedure suggested by Hair et al. (2011). So, firstly, the inter-item reliability, internal consistency reliability, and convergent validity of the proposed model were measured. Secondly, the hypotheses and predictive ability of the structural model were tested (Henseler et al., 2009).

Reliability and discriminant validity

Reliability was calculated using Anderson and Gerbing's (1988) two-step procedure for calculating convergent and discriminant validity of the constructs. For this purpose, the reliability of the constructs was tested using Confirmatory Factor Analysis (CFA), and Composite Reliability (CR) and Average Variance Extracted (AVE) were calculated afterwards.

According to Hair et al. (2011), loading factors should preferably be greater than 0.70. However, loading factors between 0.40 and 0.70 are acceptable if the AVE of the construct is greater than 0.50. In this case, some factors that had low loadings and did not meet the AVE had to be eliminated. As a result, the loadings between 0.461 and 0.880 were accepted. Thus, the results meet the reliability criteria of the factors.

In terms of internal consistency, the ideal is for CR values to be higher than 0.70 (Hair et al., 2011). In this study, after eliminating the non-significant items, the CR values range between 0.700 and 0.916. Therefore, the results meet the criteria of internal consistency. Finally, convergent validity requires an AVE for each construct greater than 0.50 (Hair et al., 2011). In this case, the AVE values are between 0.524 and 0.643 and therefore the results meet the convergent validity criteria. These results are detailed in Table 3.

Discriminant validity

To assess discriminant validity there are two main approaches (Islam et al., 2022): the Fornell and Larcker (1981) criterion and the Heterotrait-Monotrait Correlations Ratio (HTMT) criterion (Henseler et al., 2015). The Fornell and Larcker (1981) criterion suggests that the square root of the AVE of each construct should be greater than the cross-correlations between each construct and the others in the model, and never less than 0.50. Furthermore, HTMT is defined as the mean value of item correlations between related constructs to the mean value corresponding to the average of the mean correlations of items measuring the same construct (Henseler et al., 2015).

According to Hair et al., (2019), the HTMT value should be less than 0.90 for conceptually similar constructs so, as shown in Table 4 this study meets the HTMT criterion and, consequently, discriminant validity is demonstrated for all constructs of the proposed model.

Table 3 Result of the measurement model

Dimension	Item	Description	Loading factor	CR	AVE
Performance expectations	PE1	The Metaverse will allow me to access a wider range of educational opportunities	0.640	0.916	0.579
	PE2	The Metaverse will help me interact more with my colleagues	0.723		
	PE3	The Metaverse will help me interact more effectively with my peers	0.789		
	PE4	The Metaverse will help me interact more with my teachers	0.818		
	PE5	The Metaverse will help me interact more effectively with my teachers	0.841		
	PE6	The Metaverse will help me get my academic work done more quickly	0.760		
	PE7	The Metaverse will help me do my academic work more effectively	0.757		
	PE8	The Metaverse will allow me to improve my academic performance	0.742		
Effort expectations	EE1	I think it will be easy for me to learn how to use the Metaverse	0.461	0.768	0.541
	EE2	I think I'll learn to use the Metaverse quickly	0.880		
	EE3	I think the administration of the Metaverse will be intuitive and understandable	0.796		
Social influence	EE4	I think I will be able to learn to use the Metaverse without special training	0.779	0.850	0.533
	EE5	I am aware that I will need to learn how to use the Metaverse	0.761		
	EE6	I believe that using the Metaverse will make accessing educational content easier	0.780		
	SI1	I think the use of the Metaverse will be widespread in society	0.724		
	SI2	I believe that the people I interact with will use the Metaverse	0.689		
Hedonic motivation	SI3	I believe that knowing how to use the Metaverse will be an essential requirement of the future education system	0.754	0.915	0.643
	SI4	I think my teachers will include the use of the Metaverse as part of their methodological strategy	0.839		
	SI5	I think students will use the Metaverse for educational purposes	0.822		
	HM1	I have a positive attitude or expectation about using the Metaverse	8.825		
	HM2	I think I will enjoy using the Metaverse	0.757		
	HM3	I think using the Metaverse will be fun	0.811		

Table 3 (continued)

Dimension	Item	Description	Loading factor	CR	AVE
Price value	HM4	I think using the Metaverse for educational purposes will be motivating	0.749	0.834	0.558
	HM5	I think using the Metaverse for educational purposes will increase the playful component of learning	0.688		
	HM6	I think using the Metaverse will make academic education more fun	0.838		
	PV1	I believe that accessing the Metaverse will have a reasonable cost	0.704		
Facilitating conditions	PV2	I think I will be able to afford the computer equipment necessary to access the Metaverse	0.689	0.759	0.615
	PV3	I believe I can afford a connection of sufficient quality to access the Metaverse	0.869		
Habit	PV4	I believe the university will provide the infrastructure and equipment to access the Metaverse	0.878	0.700	0.524
	PV5	I believe that access to the Metaverse will allow me to recoup the costs of accessing the Metaverse	0.527		

Table 4 Fornell–Larcker and HTMT correlations matrix

	ER	EE	IS	MH	VP	CF	HA	USO
ER	**0.761**	0.578	0.540	0.581	0.498	0.280	0.171	0.454
EE	0.755	**0.735**	0.829	0.823	0.590	0.300	0.784	0.505
IS	0.646	0.589	**0.730**	0.655	0.556	0.394	0.203	0.673
MH	0.635	0.572	0.549	**0.802**	0.486	0.271	0.194	0.347
VP	0.427	0.405	0.440	0.427	**0.747**	0.530	0.123	0.385
CF	0.452	0.603	0.690	0.442	0.900	**0.784**	0.747	0.454
HA	0.637	0.201	0.727	0.636	0.556	0.114	**0.724**	0.400
USO	0.433	0.412	0.610	0.341	0.426	0.265	0.120	**1**

Fornell–Larcker: the diagonal elements (in bold) indicate the square root of the variance shared between the constructs and their measures (mean variance extracted), with the correlation between the constructs at the bottom. The HTMT coefficients are above the diagonal

Structural equation model

The hypotheses proposed in this study were evaluated using Partial Least Squares Structural Equation Modelling (PLS-SEM). For this purpose, bootstrapping with 10,000 resamples was used (see Table 5) to assess the significance of the path coefficients (Hair et al., 2017). To increase confidence in our results, we also conducted a post hoc power analysis using G*Power 3, which showed that the power value for the structural model was above the accepted cut-off of 0.80. According to achieve a common power level of at least 0.80 for path coefficients that are significant at 5% and fall between 0.11 and 0.20, a minimum sample size of 155 observations is required (Capeau et al., 2024). Therefore, our sample fulfil such criteria.

Table 5 Results of structural equation modelling after bootstrapping

	Sample mean	T Statistics
Control variables		
Academic qualification → Use	− 0.042	1.058n.s
Gender → Use	− 0.008	0.151n.s
Age → Use	0.057	1.616n.s
Direct effect		
Performance expectations → Use	0.131	1.848***
Effort expectations → Use	0.034	0.591n.s
Social influence → Use	0.514	8.970***
Hedonic motivation → Use	− 0.092	1.809n.s
Price value → Use	0.140	2.551***
Facilitating conditions → Use	− 0.028	0.653n.s
Habit → Use	0.009	0.659n.s

n.s. not significant

***p < 0.01

The above results confirm that only three of the eight proposed hypotheses are significant. Specifically, hypothesis H1, which proposes a direct effect between performance expectations and the intention to use the Metaverse as a pedagogical tool, is confirmed ($\beta = 0.514$. $p < 0.01$). Likewise, hypothesis H3, which proposes a direct effect between social influence and the intention to use the Metaverse as a pedagogical tool, is confirmed. Finally, hypothesis H5, which proposes a direct effect between price value and the intention to use the Metaverse as a pedagogical tool, is confirmed ($\beta = 0.140$. $p < 0.01$). The rest of the hypotheses proposed (H2, H4, H6 and H7), as well as the control variables, were not significant.

Discussion and conclusions

This study analyzes how different dimensions of a model based on UTAUT-2 (extended version) influence students' intentions to use the Metaverse.

In this context, the first factor that shows such an influence and that allows us to accept the first hypothesis (H1) is the one related to performance expectations, which refers to the idea that the use of the Metaverse will improve grades, which will increase the intention of its use by students. This result corroborates those obtained by Teng et al. (2022), who also used a model developed from the UTAUT-2 and found how performance expectations, effort expectations, social influence, and facilitating conditions directly influenced students' satisfaction, which was related to the continued use of the "Eduverse" Metaverse. In the same vein, Alkhwaldi (2023) identified factors influencing users' intentions towards Metaverse technology for educational purposes in Jordanian universities and found that performance expectations had a significant influence. However, in that study, the influence of facilitating conditions and hedonic motivation were also significant, which contradicts the results of the present study. Lee and Kim (2022) also used a UTAUT-based model and concluded that performance expectations, effort expectations, and social influence of the Metaverse platform "Ifland" increased satisfaction, usage intention, and purchase intention. Similarly, but in a different context such as smart manufacturing, Byoung-gyu (2021) also showed that performance expectations are broadly related to Metaverse usage intention.

As can be seen, the study by Teng et al. (2022) also confirms the results obtained in this research in terms of social influence, which allows us to accept the third hypothesis (H3). Thus, it can be assumed that the perception that the Metaverse will be a widely accepted reality in the educational environment due to its widespread use by institutions (Area & Adell, 2021), teachers, and students will increase the intention to use it. The results of Ji-Hee (2021) show that this factor predicted the intention to use the Metaverse as perceived usefulness increased, and those of Wan and Shin (2022) follow the same trend. However, it should also be noted that some studies, such as Alkhwaldi's (2024), have not been able to demonstrate the predictive ability of social influence with respect to acceptance and adoption of the metaverse, something that occurs with performance expectations. In any case, it seems to be consistent evidence that both variables influence the intention to use this technology, since both appear in first and second place in a list that refers to the importance of

the predictive variables of the phenomenon, which has been measured taking into account the number of studies that consider them (Alfaisal et al., 2024).

Then, the value of the price shows that the easier it is to pay or cover the cost of access to the equipment or infrastructure is associated with a greater intention to use it, which allows us to accept the fifth hypothesis (H5). However, there are contradictory results for this indicator. Thus, although this factor is not significant in the study of Teng et al. (2022), it is significant in the study of Mohamad et al. (2022), because in this case, although the relationship is negative, the study asks about the high cost of the equipment. Similarly, in the study by Lee et al. (2023) in the Vietnamese context, price value is revealed as a variable that positively affects the intention to adopt Metaverse platforms.

Finally, the results obtained do not support the existence of influential relationships between the remaining dimensions and the intention to use, which allows us to accept the hypotheses related to effort expectations (H2) and facilitating conditions (H6), and to reject the remaining hypotheses related to hedonic motivation (H4) and habits (H7). These results are largely consistent with those of Yang et al. (2022), who in their analysis of the use of the Metaverse for basketball learning also rejected the hypotheses related to effort expectancies, facilitating conditions, and hedonic motivation. Only in the case of habit there are discrepancies, which could be attributed to the very specific characteristics of the learning content and to the still experimental nature of the use of the Metaverse.

Theoretical and practical implications

In terms of the theoretical implications of the research, the present study deals with the conceptualization of a model based on the UTAUT-2, which is often used to measure the degree of acceptance of different technologies in different environments (Hilal & Varela-Neira, 2022). In fact, models based on the UTAUT-2 have been used recently to assess the adoption of technologies in the educational environment, because of the rapid evolution of technologies and their applications (Meet et al., 2022) and of the supervening circumstances due to the COVID-19 pandemic (Raman & Thannimalai, 2021). Thus, the research deepens the theoretical understanding of digital innovation procedures (Alonso de Castro & García-Peñalvo, 2022) and the configuration of technological attitudes (Martín-Ramallal & Merchán-Murillo, 2019), which provides insight into the facilitating and resisting factors that influence the adoption of new technologies such as the Metaverse.

In terms of practical implications, relevant information is provided to the different actors involved in the process of designing and implementing the Metaverse. First of all, to the technology development companies, since the results show that some factors are crucial for their acceptance (Alcázar, 2022).

For example, students seem to be willing to make an extra effort or face some difficulties to adapt to the Metaverse, but they do not seem to be willing to accept a high cost associated with its use. Therefore, companies should focus much of their efforts on reducing the price of the equipment and infrastructure necessary for its

use. They should also promote everything related to its educational usefulness, since its acceptance will improve according to its ability to increase performance.

In terms of contextual implications, the relationship between this technology and universities is relevant. Indeed, one way to encourage the use of this technology is to reduce the cost to students by facilitating access from the institution itself.

Finally, it is indispensable to consider the need to couple this technology to the educational environment, since its objective of improving academic performance cannot be achieved without the necessary contextualization in the teaching–learning processes, which requires profound methodological adaptations and a complete change in the instructional design of educational content (Avalos & Castellanos, 2022), directly involving the teaching staff. In fact, this cannot be done without significant training efforts, which should also be extended to students.

Limitations and future work

Despite the interest and relevance of the results obtained, the study has some limitations that should be addressed. Thus, it seems appropriate to increase the sample, which should be stratified by degrees and fields of knowledge. Besides, it may be useful to extend the study to other Spanish universities or to different educational modalities (face-to-face, online, hybrid…). On the other hand, the power of the study would be significantly increased if, before filling out the questionnaire, students could be given access to the Metaverse, so that instead of watching an informative video, they could access it with the appropriate equipment in a real environment. Moreover, the design and configuration of this kind of research is such that it is suitable for use at levels of education other than university level, as well as in other educational institutions. This would be an interesting direction for future developments, through the design of content adapted to the Metaverse, which could already be used to teach courses through this medium and to analyze educational experiences in this environment.

Conclusions

The Metaverse is a tool that, beyond its recreational or social applications, can have significant educational potential and value. In fact, students are aware of its usefulness in improving their academic performance, which, together with the benefits it can bring to their studies and a possible massive acceptance by the student community, will significantly condition its final adoption by this group. This, of course, obliges university institutions to consider it in their technological adaptation and pedagogical planning processes. In short, the integration of the Metaverse in the academic environment is a new challenge that poses some difficulties, but also represents an opportunity to make a qualitative leap in the teaching–learning processes, taking advantage of the enormous impulse of information and communication technologies, something that could revolutionize the methodological approaches within the university context.

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